



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification⁶ : B32B 3/02, A47K 7/02	A1	(11) International Publication Number: WO 98/45112 (43) International Publication Date: 15 October 1998 (15.10.98)
(21) International Application Number: PCT/US98/06757 (22) International Filing Date: 3 April 1998 (03.04.98) (30) Priority Data: 60/043,405 4 April 1997 (04.04.97) US (71) Applicant: RODEL HOLDINGS, INC. [US/US]; 451 Bellevue Road, Newark, DE 19713 (US). (72) Inventors: REINHARDT, Heinz, F.; 19 McCarthy Road, Chadds Ford, PA 19317 (US). JENSEN, Elmer, William; 325 South DuPont Highway, New Castle, DE 19720 (US). (74) Agent: BENSON, Kenneth, A.; Rodel Holdings, Inc., 451 Bellevue Road, Newark, DE 19713 (US).		(81) Designated States: CN, JP, KR, SG, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i>
(54) Title: POLISHING PADS AND METHODS RELATING THERETO (57) Abstract A polishing pad is provided which is comprised of vertically oriented fibers. Such pads can be produced by electrostatically flocking fibers onto a substrate. Preferably the fibers are hollow.		

BEST AVAILABLE COPY

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Larvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakistan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

POLISHING PADS AND METHODS RELATING THERETO

5 This application claims the benefit of U. S. Provisional
Application No. 60/043405 filed on April 4, 1997.

BACKGROUND OF THE INVENTION

Field of the Invention

10 The present invention relates to polishing pads used for
creating a smooth, ultra-flat surface on such items as glass,
semiconductors, dielectric/metal composites and integrated circuits.

Description of Related Art

15 Polishing generally consists of the controlled wear of an
initially rough surface to produce a smooth specular finished
surface. This is commonly accomplished by rubbing a pad against
the surface of the article to be polished (the workpiece) in a
repetitive, regular motion while a solution containing a suspension
of fine particles (the slurry) is present at the interface between the
20 polishing pad and the workpiece.

Polishing pads are normally produced by impregnation of
felt with polymer solutions using water miscible solvents such as
DMF followed by coagulation with water or water solvent blends,
then drying and buffing or splitting/buffing. In another process the
25 polymer solution is coated onto a substrate followed by
coagulating. This process leads to the formation of vertically
oriented pores (VO pores) which serve as slurry reservoir during

polishing. The impregnation/coagulating method gives material with mostly horizontally oriented fibers and the coating method results in a coating without any fiber reinforcement except the fibers present in the substrate. The only way to make polishing
5 material with vertically oriented fibers is by laminating horizontally oriented product to make a vertically oriented product such as described in US Patent No. 4,728,552.

A patent which shows one method of forming a polishing sheet material with pores on the surface to provide slurry reservoir
10 is US Patent No. 4,753,838. The pad surface is made of cellular polyurethane.

SUMMARY OF THE INVENTION

A polishing pad is provided which is comprised of vertically
15 oriented fibers. Such pads can be produced by electrostatically flocking fibers onto a substrate. Preferably the fibers are hollow. Optionally, the pad comprised of vertically oriented fibers may be coated with a polymer solution to fill the voids between the fibers. The surface of pads coated with a polymer solution may be sanded
20 to remove polymer skin and open the hollow fiber ends.

A method for polishing a workpiece is provided wherein polishing pads as described above are used to planarize a workpiece by contacting the surface of the polishing pad and a

surface of the workpiece while there is motion between the polishing pad and the workpiece.

DETAILED DESCRIPTION OF THE INVENTION

5 A process has been developed to make polishing pads containing vertically oriented fibers by electrostatically flocking fibers vertically onto substrates. The material may then be coated with polymer solution to fill the voids between the fibers. No polymer coating/impregnation may be needed if the fibers are
10 flocked very densely. Of particular interest is a process variation which uses hollow or multichannel fibers such as hollow polyester or nylon fibers. This results in surface structures with increased slurry reservoir. Hollow polyester and nylon fibers are commercially available as well as higher denier triocular and
15 tetraocular nylon (Tynex, a trademark of the DuPont Company). Hollow fiber felts made by electrostatic flocking and used for the impregnation/coagulating process give polishing surfaces with vertically oriented hollow fibers which act as slurry reservoir by themselves or in combination with the pores generated during
20 coagulation. This process results in a new type of polishing pad which not only has vertically oriented fiber reinforcement but also has increased slurry uptake because of the hollow nature of the fiber used.

A variety of samples were prepared by flocking solid and one- or multichannel fibers electrostatically onto substrates with most of the fibers vertically oriented. Microscope examination of flocked fiber samples show nearly 100% vertical fiber orientation.

5 The fiber flock used was usually between 0.4 to 0.8 mm in length. Hollow fibers used in the experiments included hollow polyester and 3- and 4- channel nylon. Some samples were coated with polyurethane solutions to fill the voids between the fibers. The coagulated material was sanded to remove the skin and to open the

10 hollow fiber ends and pores in the polymer.

Fibers flocked onto a polymer film or onto a foamed backing (such as foamed rubber) provided surfaces which would make excellent pads for chemical mechanical planarization. The surface was very uniform and choice of backing material makes it possible

15 to obtain the desired stiffness or resilience for a given polishing operation.

Electrostatic flocking of short, high denier fibers is a well known art. Any type of adhesive may be used to adhere the vertically oriented fibers to a substrate. The adhesive may be a hot

20 melt, aqueous based, or solvent based. For the purpose of making the surface layer of a pad useful for chemical mechanical polishing of a workpiece, such as a semiconductor wafer, the adhesive needs to be resistant to water and alkaline conditions up to a pH of 12. Since polyurethanes are commonly used in the manufacture of pads

for chemical mechanical polishing, they are a preferred material for the flocking process adhesive.

The scope of the invention is limited only by the claims which follow.

CLAIMS

1. A polishing pad comprised of vertically oriented fibers said pad being produced by electrostatically flocking fibers onto a substrate.
- 5 2. A polishing pad according to claim 1 wherein said fibers are hollow.
3. A polishing pad according to claim 1 wherein said pad comprised of said fibers electrostatically flocked onto said substrate is coated with a polymer solution to fill the voids
10 between said fibers.
4. A polishing pad according to claim 2 wherein said pad comprised of said fibers electrostatically flocked onto said substrate is coated with a polymer solution to fill the voids between said fibers.
- 15 5. A polishing pad according to claim 4 wherein the surface of said coated pad is sanded to remove polymer skin and open the hollow fiber ends.
6. A polishing pad according to claim 4 wherein said polymer solution is a urethane polymer solution.
- 20 7. A polishing pad according to claim 2 wherein said fibers are polyester or nylon.
8. A polishing pad according to claim 1 wherein said fibers are between about 0.4 and 0.8 mm in length.

9. A polishing pad according to claim 2 wherein said fibers are between about 0.4 and 0.8 mm in length.
10. A method for polishing a workpiece comprising: (a) providing a polishing pad comprised of vertically oriented fibers said pad being produced by electrostatically flocking fibers onto a substrate, (b) planarizing said workpiece by contacting the surface of said polishing pad and said workpiece while there is motion between said polishing pad and said workpiece.
11. A method according to claim 10 wherein said fibers are hollow.
- 10 12. A method according to claim 10 wherein said pad comprised of said fibers electrostatically flocked onto said substrate is coated with a polymer solution to fill the voids between said fibers.
13. A method according to claim 11 wherein said pad comprised of said fibers electrostatically flocked onto said substrate is coated with a polymer solution to fill the voids between said fibers.
- 15 14. A method according to claim 13 wherein the surface of said coated pad is sanded to remove polymer skin and open the hollow fiber ends.
15. A method according to claim 13 wherein said polymer solution is a urethane polymer solution.
- 20 16. A method according to claim 11 wherein said fibers are polyester or nylon.
17. A method according to claim 10 wherein said fibers are between about 0.4 and 0.8 mm in length.

18. A method according to claim 10 wherein said fibers are between about 0.4 and 0.8 mm in length.

INTERNATIONAL SEARCH REPORT

International application No.
US98/06757

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B32B 3/02; A47K 7/02

US CL :428/90; 15/209.1

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 428/90; 15/209.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3,772,132 A (DULIN, JR.) 13 November 1973, see entire document.	1, 3, 8
--		-----
Y		2, 4-7, 9-18
Y	US 5,569,521 A (FRANCOEUR, SR. et al.) 29 October 1996, see entire document.	1-18

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:	*T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
A document defining the general state of the art which is not considered to be of particular relevance	*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
B earlier document published on or after the international filing date	*Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	*Z* document member of the same patent family
O document referring to an oral disclosure, use, exhibition or other means	
P document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

18 JUNE 1998

Date of mailing of the international search report

14 JUL 1998

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer
B. H. Morris
TERREL MORRIS

Telephone No. (703) 308-2351

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☒ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.